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ABSTRACT

One hundred and twenty kindergarten and second grade children from 3 different language environments (40 Mexican Spanish-speaking children from Monterrey, Mexico, and 40 Chicano Spanish-speaking children and 40 English-speaking children from the same public elementary school in Houston, Texas) were given a perceptual matching test and a verbal communication test to examine the relationship between language and cognitive performance. Because of the processing demands imposed by English adjective ordering rules, the English-speaking group had a significantly lower performance score on the communication task and on the perceptual task than the two Spanish-speaking groups. Initially, the Chicano children performed significantly better than the Mexican children. However, the Mexican group showed the greatest gain across grade levels, possibly because Mexican children are exposed to the kinds of curricular activities that facilitate performance on perceptual and communication tasks by age seven, even though Mexico has few kindergartens. The decline in the rate of linguistic development across grades for the Chicano children was attributed to the fact that the use of Spanish by Mexican American children is often not encouraged as they get older, even in bilingual education situations. Data indicated a need for further cross-cultural work to map the differential effects of languages on childrens' ability to perform cognitive tasks. (CM)

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# English and Spanish-speaking Children's Performance on Perceptual and Communication Tasks: A Cross-Cultural Study of Language and Cognition

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Abstract

120 kindergarten and second grade children from three different language environments were given a perceptual matching test and a verbal communication test to examine the relationship between language and cognitive performance. The three language groups included 40 Mexican Spanish-speaking children from Monterrey, Mexico, and 40 Chicano Spanish-speaking children, and 40 English-speaking children from Houston, Texas. The English speaking group had significantly lower performance on the communication task than the two Spanish-speaking groups. The processing demands imposed by English adjective ordering rules accounted for this difference in performance. The English speakers also performed significantly lower on the perceptual task, perhaps for the same reason. Implications for education were discussed.

# English and Spanish-speaking Children's Performance on Perceptual and Communication Tasks: A Cross-Cultural Study of Language and Cognition

The relationship between language and thought has long been debated. Yet the debate has focused on global differences between the functions of language and thought (e.g., the Piagetian versus the Vygotskyan perspective) or on global linguistic differences which influence cognitive performance (e.g., Whorf's linguistic relativity hypothesis). Here we focus the language and thought debate on a set of predictions about a specific linguistic feature's effects on specific aspects of cognitive performance. In particular, we predicted that in a communication task employing linguistic rules which vary in complexity and acquisition rate across languages, children with similar processing space but different languages would not perform the same. However, in a perceptual matching task in which a language mediation strategy could be invoked to label relevant attributes without linguistically coordinating them, one would not necessarily expect differences in performance across language groups. The present investigation had young American English-speaking and Mexican Spanish-speaking children do each of these kinds of tasks. To control the influence of culture on cognitive and linguistic performance a group of Spanish-speaking children from the same school as the English-speaking children was included.

A linguistic feature thought to influence cognitive performance is the prenominal adjective ordering rule in English (Freedle & Hall, 1973; Foorman, 1975; Ford & Olson, 1975; Richards, 1979). This rule dictates the order of prenominal adjectives. For example, Foorman (1975) found that adult English speakers, when asked to distinguish one wooden animal from others by attributes of size, color, pattern, and shape, produced descriptions ordering size first, then color, pattern, and shape. Adults would say a <u>big, brown, spotted dog</u> but not <u>a spotted, brown, big dog</u>. (One can imagine an acceptable context: "It is the <u>spotted</u>, big, brown dog that bit the

mailman." However, the aberrant ordering is alleviated by the use of stress on the adjective "spotted.")

Explanations have been offered for such adjective ordering constraints. They range from linguists' emphasis on complexity of transformations (Vendler, 1968) and semantic notions of "sets" (Quirk et al, 1972) or class memberships (Hill, 1958; Strang, 1968; Crystal, 1971) or "denotative definiteness" (Martin, 1969, a,b) to psycholinguists' emphasis on informativeness in the communication context (Bever, 1970, 1974; Danks & Glucksberg, 1971; Freedle & Hall, 1973; Schwenk & Danks, 1974; Bacharach & Maisto, 1974).

To the psycholinguists' emphasis on informativeness in the communication context we add the neo-Piagetian perspective of Pascual-Leone's Theory of Constructive Operators (Pascual-Leone, 1976; Pascual-Leone et al, 1978; Ammon, 1977). Two aspects of Pascual-Leone's theory are central to this investigation. First, increasing amounts of mental processing space explains the maturational component of development (Pascual-Leone, 1970). Second, the relative cognitive complexity of various tasks can be assessed in terms of requisite processing space (Pascual-Leone and Smith, 1969; Case, 1974; de Ribaupierre and Pascual-Leone, 1979; Foorman, Note 1). In predicting difference in communication performance in English-speaking and Spanish-speaking children of the same processing capacity, we assume that English language rules for prenominal adjective ordering are more complex than Spanish language rules for coordinating adjectives in demanding more processing space. In Spanish there is a preferred ordering of form, size, color, and pattern (e.g., un perrito cafe con bolitas). But less processing space is demanded in coordinating these four attributes for two reasons. First, the primary position of form in Spanish allows for linguistic coding to match perceptual saliency. Both form and color are perceptually salient attributes for young children. In English preferred ordering mandates the mention of size first. The relativistic nature of size suggests its lesser perceptual saliency. To verbally encode this relatively unsalient attribute first, the saliency of form and color must be ignored. In Pascual-Leone's theory this process of ignoring or overcoming "field

effects" demands mental processing space (cf. Pascual-Leone et al, 1978; Ammon, 1980). If these processing demands vary across language groups and are activated in a cognitively "high workload" task (cf, Shatz, 1977), one expects performance differences between language groups.

The second reason why Spanish language rules for coordinating attributes seem less cognitively demanding than English ones has to do with the chunking of information. In Spanish size (e.g., chiquito or grande) can be subsumed into shape (e.g., perro) by means of the suffix "-to" or "-te" (i.e., perrito or perrote). Such chunking reduces demands on processing. Moreover, in English the alternative to prenominal adjective ordering is postnominal ordering. The problem with postnominal ordering in English is that multiple relative clauses are required in order to coordinate four attributes within one utterance (e.g., A dog that's little and brown and has stripes). However, in Spanish these same four attributes can be coordinated in several ways, using only one relative clause (e.g., un perrito cafe que tiene bolitas; un perro chiquito con bolitas que es cafe; or un perro cafe con bolitas que es chiquito).

To show the link between processing space and linguistic rule performance a task was selected which required the subject to verbally encode four attributes so that an adult could locate the animal from an array of animals that included all logical combinations of attributes (cf. Foorman, 1975 and 1980; Glucksberg, Krauss, & Higgins, 1975; Dickson, 1980). Decoding of the same attributes was also assessed by asking subjects to evaluate various orderings. Age groups were selected to distinguish knowledge about a rule from fully successful use. In an earlier study (Foorman, 1975) both five and seven year olds demonstrated that they "knew" the prenominal adjective ordering rule in English by their attempts to coordinate attributes by the rule. However, five year olds were able to coordinate on the average only two attributes within one utterance (e.g., "It's a brown dog") while 7 year olds were coordinating three and four attributes. Often the five year olds would begin a description with the shape attribute and then have to start again to insert another attribute: "It's a dog...um, It's a brown dog...It's a brown dog

with spots. By age seven English speakers acquired productive rules for prenominal adjective ordering and coordinated all four attributes with relative ease; however, only a few seven year olds could make explicit grammatical judgments about different orderings. Significantly, no subject spewed out attributes in a manner that disobeyed prenominal adjective ordering rules in English. Often one or two attributes would be encoded in separate noun-verb structures (e.g., "It's a dog. It's brown.") but the task requirement to include all four relevant attributes in a description seemed to force linguistic coordination rather than to extend linguistic production beyond limited processing space (of the speaker, we assume, but perhaps of the listener as well). The case of the seven year olds who produced informative descriptions without requiring listener feedback is relevant here. At first they strung attributes out in separate utterances. However, with practice they began to compact relevant information into encodings which conformed to prenominal adjective ordering rules.

In sum, we examined English and Spanish-speaking children's linguistic coordination of four relevant attributes in a referential communication task and their matching of these same attributes in a perceptual task. The language groups were controlled within the five and seven year old age levels demonstrating "knowledge about" versus "knowledge how to" produce English prenominal adjective ordering rules by performance on a mental processing space measure called Mr. Cucui (Diaz, 1974). The range of scores on this measure (described in the next section) that corresponded to the number of schemes typically coordinated by children at ages 5-6 and 7-8 (Pascual-Leone & Smith, 1969) was used as a selection criteria for subjects. Since subjects were drawn from kindergarten and second grade classrooms the word "grade level" rather than "ages" conveys the experiental contribution to this variable as well as the maturational component addressed by the Cucui test. We predicted that language groups would not differ significantly in the number or order of matches on the perceptual task, but would differ significantly in the number, order, and linguistic coordination of attributes produced in the communication task as well as

the amount of listener feedback required. Differences were expected to favor the Spanish-speaking groups. A main effect of grade level was not expected in the communication task because relatively few English-speaking second graders could demonstrate prenominal adjective ordering rules for all four relevant attributes. However, interactions of grade level with language group were expected.

## Method

### Subjects

The investigation involved 120 children in kindergarten and second grades from Mexican Spanish-speaking, Chicano Spanish-speaking, and English-speaking environments. The Chicano Spanish and English groups were drawn from the same public elementary school in Houston, Texas. The Chicano Spanish-speaking children were American born and of Mexican descent and were described by their teachers as dominant in Spanish. Monterrey, Mexico was selected as the site for the Mexican Spanish-speaking subjects because Monterrey is a large contributer to the Chicano Spanish-speaking population in Texas (Cornelius, 1978). The school for the children of the employees of Cuauhtemoc Brewery was selected in Monterrey because this school contained a kindergarten (whereas most public schools in Mexico do not) and served a population comparable in socioeconomic status (i.e., lower-middle class) to the Houston sample. Average ages of the Mexican Spanish-speaking kindergarten and second grade groups were 5;10 and 7;7. For the Chicano Spanish-speaking groups the average ages were 5;9 and 7;8, and for the English-speaking groups the average ages were 5;9 and 7;9.

### Procedure

Each child was individually tested in his/her dominant language on a set of three tasks: 1) a short-term memory task called Mr. Cucui (Diaz, 1974); 2) a perceptual matching task; and 3) a referential communication task. The tasks were administered to each language group by an adult female of the same language/cultural group. The one exception to this format was with the perceptual task for the Chicano-Spanish speakers. Due to the lack of time remaining in the school year

the testing was conducted by the Mexican experimenter rather than by the Mexican-American experimenter.

Mr. Cucui (Diaz, 1974) is a mental processing space measure in which the subject must remember the number of spots of color that appear on a picture of a potatoman. The number of spots of color ranged from 0 to 4, with five items at each level. The scoring procedure consisted of assigning one point if 4 out of 5 items in a level are "passed" and an additional 1/5 of a point for subsequent items "passed." Subjects whose Cucui scores fell into ranges predicted by Pascual-Leone's theory (1.6 to 2.6 for kindergartners and 2.8-3.6 for second graders; cf., Foorman, Note 1) were selected to participate in the perceptual and communication tasks. Only two subjects (one English-speaking and one Mexican Spanish-speaking) were excluded from the study for having scores below the expected age range and five English-speaking and 11 Spanish-speaking (5 Mexican, 6 Chicano) were excluded for having scores above their expected age range. Similar distribution of scores for each language group were obtained.

The perceptual matching task (Toki, 1974, Note 2) consisted of matching three dimensional wooden objects according to attributes of size, color, substance, and shape. There were five trials, each consisting of a target attribute block and an array of four attribute blocks. For example, one array consisted of: 1) a small, red, plain circle; 2) a large, blue, striped triangle; 3) a large, green, plain square; and 4) a large, yellow, plain diamond. The child was handed a stimulus object and asked "find me one like this one." The experimenter pointed to the object in hand and then to the array. For instance, if the child was handed a small, yellow, striped square he or she might point to the first object in the array on the basis of size, the second object on the basis of stripes, the third object on the basis of shape, and the fourth object on the basis of color. Each was encouraged to make as many matchings as possible. Data from this task was analyzed by focusing on (1) the number of times across five trials that a child selected the attributes of color, shape, size, or substances and (2) the

number of times that each attribute was selected first, second, third, or fourth.

The referential communication task (Foorman, 1975) was a game where a child was asked to choose an animal from a group of wooden animals which varied on the attributes of shape (camel, dog), color (yellow, brown), size (large, small) and substance (stripes, spots). Knowledge of these attribute values was assessed pre-experimentally by showing each child a picture of each attribute and asking for a label or description. The only label that occasionally was not known by all three language groups was "camel." When the experimenter asked these uncertain children if the pictures could be a camel all agreed immediately and proceeded to use the term productively in the referential task.

While the child was making his or her selection in the referential communication game, the experimenter hid her eyes so that the child would have time to put the selected animal in a box provided. (The child was encouraged to keep looking into the box so that he or she did not forget what the animal looked like.) Once an animal had been selected and hidden the experimenter asked the child to "tell me how it looks so that I can try to find it." If the child's initial description did not contain all four attributes needed to distinguish the selected animal from the others in the array, the experimenter picked from the array an animal which fit what the child had said but was maximally different on all other attributes. For example, if the child has selected a <u>small, yellow, spotted camel</u> but merely says " a yellow one" when asked to describe it, the experimenter would show the child a <u>big, yellow, striped dog</u> and ask the child if this was the selected animal. Upon seeing such concrete evidence of their verbalization, children almost always react quickly by adding more relevant features, such as "no, it's small and it's a camel." Three of the relevant attributes have now been mentioned--that is, that it is small, yellow, and a camel. The experimenter can elicit the final attribute--spots--by showing the child another animal which is consistent with the mentioned attributes but contains stripes rather than spots. Through such an elicitation procedure attention can be paid both to the number of relevant attributes mentioned

in the initial description and then to the number of contrasts required before a sufficiently discriminating description is achieved. The number of contrasts could range from 0 to 4, four being the maximum number of attributes.

Attention was also paid to the child's ability to coordinate the attributes linguistically. This ability was tested by having the experimenter ask the child, after the conclusion of the elicitation procedure, "to tell me again how the animal looks so that I can write it down." This final description was scored on a 0 to 3 point scale with intervals of one-half of a point, according to the number of adjectives produced and the extent to which they were coordinated within a single Noun + Verb construction. An inter-rater reliability coefficient of .92 was obtained on the Anglo, Mexican, and Chicano experimenters' use of these criteria. The following examples are given of the scoring system (and a more detailed description may be obtained by writing the senior author):

0 points: No relevant attributes or only 1. (e.g., "a dog." "Es un animalito.")

.5 points: 2 relevant attributes conjoined merely by the word "and" or by two verbs or by "and" + Verb. (e.g., "Un camello y es amarillo")

1 point: 2 relevant attributes which are conjoined by Verb + "and" or gramatically acceptable compacting (e.g., "perrito" or "A camel with spots").

1.5 points: 3 relevant attributes which are conjoined by the word "and" or by more than one verb, or by a medial verb (e.g., "un perrito con rayas y es amarillo").

2 points: 3 relevant attributes which are conjoined by gramatically acceptable compacting (e.g., "A big, brown dog" or "un camello amarillo con bolitas").

2.5 points: 4 relevant attributes which are conjoined by the word "and" or by more than one verb or by a medial verb (e.g., "It's a little brown dog and it has stripes").

3 points: 4 relevant attributes which are conjoined by gramatically acceptable compacting (e.g., "A big, brown, striped dog," "un perro grande cafe con rayas").

At the end of the referential communication task, English-speaking children were given several orders of attributes from the game and asked which sounded "o.k." to them (i.e., spotted, brown, big dog). In this way, comprehension as well as production of attribute ordering was assessed.

## Results

Analyses of variance with repeated measures were performed on the number of attributes matched in the perceptual task and in the communication task (before and after feedback) and on the number of steps of feedback in the communication task. Independent variables were language group, grade level, and trials. In addition to the ANOVAS, separate chi-squares for language group and for grade level were performed on the attribute orders demonstrated in the perceptual and communication tasks and on the linguistic coordination of the descriptions in the communication task. Moreover, correlations within language group were obtained for dependent variables of the communication task and grade level. First, results on the communication task will be presented.

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Insert Table 1 about here

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Table 1 provides the means for the communication and perceptual task measures, broken down by language group and grade level. In the communication task there were significant language group differences in the number of relevant attributes produced in the initial encoding ($F_{2,114} = 131.18$, $p < .01$), and

in the final encoding ($F_{2,114} = 32.11$, $p < .01$), and in the number of steps of feedback ($F_{2,114} = 44.87$, $p < .01$). Post-hoc analysis utilizing the Scheffé statistic revealed the differences to be due to the superior performance of the Chicano-Spanish speakers in the analysis of initial encodings and in the analysis of steps of feedback, and to the superior performance of both Spanish-speaking groups in the analysis of final encodings. This final encoding analysis also revealed a significant main effect of grade level ($F_{1,114} = 12.65$, $p < .01$), favoring the second grade and an interaction of grade level with language group ($F_{2,114} = 4.25$, $p < .017$). By examining the means in Table 1 we see that English-speaking kindergartners and second graders were performing similarly, whereas Spanish-speaking second graders were outperforming kindergartners.

Chi-square analyses were performed on the degree of linguistic coordination in the initial encodings and in the final encoding given after the experimenter asked the child to describe the animal again so that she could write down the description. There were significant language group differences in both analyses: $\chi^2_2 = 49.52$, $p < .01$ for the initial encoding analysis and $\chi^2_2 = 32.10$, $p < .01$ for the final encoding analysis. Table 2 gives the number of subjects in each language group whose linguistic coordination scores across the five trials were below the median and above the median.

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Insert Table 2 about here

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As can be seen by comparing language group performance within and across initial and final encodings, many more English speakers produced relatively uncoordinated encodings (both initially and finally) than either of the Spanish-speaking groups. When the two Spanish-speaking groups are compared an interesting shift can be noted across encodings: Initially many Chicano children produced relatively coordinated encodings, whereas the Mexican children were more evenly split in

terms of their level of linguistic coordination. But in the final encoding the reverse pattern appears. Chicano children were evenly split and it is the Mexican children who were producing relatively greater linguistic coordination.

The significant relationships between linguistic coordination and language group revealed in the chi-square analysis was also supported by a correlational analysis. With Spanish speakers' scores combined, there were significant correlations between language group and linguistic coordination in initial encodings ($r = .49$, $p < .001$) and final encodings ($r = .48$, $p < .001$). Intercorrelations of communication task measures and grade level within each language group revealed two interesting points. First, for the Mexican group grade level was significanly correlated both with the number of attributes given in the final encoding ($r = .64$, $p < .001$) and with the level of linguistic coordination in the final encoding ($r = .55$, $p < .001$). Second, while the relationship between feedback and the linguistic coordination of final encodings was significant for the Spanish-speaking groups ($r = .43$, $p < .003$ for the Chicano and $r = .40$, $p < .005$ for the Mexican group), the relationship was not significant for the English-speaking group ($r = .32$, $p < .01$). In other words, for the English speakers a reduced need for feedback did not result in more coordinated final encodings, as it did for the Spanish-speaking groups.

Analysis of variance on the number of attributes matched in the perceptual task revealed significant main effects of language group ($F_{2,114} = 10.83$, $p < .01$) and trials ($F_{4,456} = 7.10$, $p < .001$) and significant interactions of trial x language group ($F_{8,456} = 3.47$, $p < .001$) and trial x grade level ($F_{4,456} = 3.90$, $p < .01$). Post-hoc analysis utilizing the Scheffé statistic showed the language group differences to be due to the greater number of matches made by both Spanish-speaking groups. Figure 1 portrays the interactions of trials with grade level and with language group.

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Insert Figure 1 about here

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As Figure 1 clearly reveals, the trial x grade level interaction is due to the gradual improvement in performance across trials for the kindergartners compared to the slight decline in performance across the first three trials followed by improvement in the second grade. The trial x language group interaction reveals that the Spanish-speaking groups improved performance across trials whereas the English-speaking group did not.

Analysis of attribute orders in the perceptual and communication tasks focused on the first attribute matched or produced by each language group on peak trials. Chi-square analysis of first-matched attributes in the perceptual task revealed significant language group differences ($X^2_6 = 14.20$, $p < .027$). The English-speaking group predominantly chose shape first; the Chicano group chose color, shape, and substance; and the Mexican group chose color and substance. There were also significant language group differences in first-mentioned attributes in the communication task ($X^2_8 = 53.59$, $p < .01$) and these differed slightly from the order revealed in the perceptual task. In the final encodings of the communication task color was the most frequent first attribute for the English group, whereas shape was the most frequent for both Spanish-speaking groups.

The results of the scrambled attribute orders given to the English-speaking subjects were insignificant. Only one subject out of 40 comprehended incorrect and correct ordering. Although the analyses presented above do suggest that the English children had difficulty producing correct attribute orders, it is perhaps unfair to conclude from this one test that they also have difficulty comprehending them. The nature of the task instructions was probably too difficult for kindergarteners and second graders.

## Discussion

In this investigation we focused on the fact that at certain periods in language acquisition the processing demands imposed by specific linguistic rules may inhibit communication performance differentially. Linguistic rules require mental processing space. Some rules take more space than others and,

therefore, are acquired later. The rule governing the ordering of four adjectives in English is acquired relatively late and, therefore, can be thought of as requiring more processing space than the postnominal structure for coordinating four attributes in Spanish. Consequently, we predicted Spanish speakers would produce more relevant attributes and coordinate them more fully than the English speakers. With processing capacity controlled across language groups by performance on Mr. Cucui, this prediction was clearly demonstrated by the relatively poor performance of the English-speaking children in the communication task. English speakers (in both kindergarten and second grade) produced significantly less relevant attributes in final encodings after all relevant attributes had been elicited than both groups of Spanish speakers. Moreover, English speakers produced significantly fewer relevant attributes in initial encodings and required significantly more feedback than the Chicano speakers. The degree of linguistic coordination in initial and final encodings was also significantly less for English speakers than for Spanish speakers.

Language group differences favoring the Spanish speakers also were demonstrated on the perceptual task, although differences in performance had not been predicted. One post-hoc explanation for these differences is that children employ a verbal labelling strategy in coding perceptual matches. Consequently, English-speaking children's use of this strategy might actually inhibit performance to the extent that prenominal adjective ordering rules were required. We did not advance such an hypothesis because matches are made on the basis of one attribute at a time, up to the maximum of four. A verbal labelling strategy imposed on such sequential behavior would not seem to entail a linguistic rule for the simultaneous encoding of the four attributes. The analysis of first-mentioned attributes in the communication task supports adjective ordering rules but the same analysis in the perceptual task does not. In the communication task color was most frequently mentioned first by English speakers, whereas shape was most frequently mentioned first by Spanish speakers. In the perceptual

task the results were the exact opposite. English speakers' first match was shape, while Spanish speakers' first match was color (with shape second for the Chicano group). Given the syntactic structure of Spanish for coordinating attributes, one is not surprised to find shape the first-mentioned attribute on the communication task for Spanish speakers. Likewise, one is not surprised to find color the first-mentioned attribute for the English speakers because of the complexity of prenominal adjective ordering rules in English (which would mandate the mention of size first). Color is a salient attribute and a compelling one to overcome in favor of a linguistic rule demanded by a communication task. Yet in a task where such a linguistic rule is not demanded, such as the perceptual task, it is quite reasonable to expect young children to match on the basis of color, as the Spanish-speaking children predominantly did, or on the basis of shape, as the English-speaking children did. Given the emphasis on letter discrimination skills in beginning reading instruction in the United States it is not surprising for matches to be made first on the basis of shape. But why, then, are the Chicano children matching on the basis of shape second and color first?

The answer to this question is not immediately obvious. Examination of children's reasons for their matches following the final trial revealed typical grade level differences: second graders tended to give category names (e.g., "They're the same shape") while kindergarteners tended to give value names (e.g., "They're both yellow"), and idiocyncratic reasons (e.g., "I saw them before"). Moreover, category names were more frequent among American children (English- and Spanish-speaking) than Mexican children. One plausible explanation for this finding is the early emphasis on attribute identification in American schooling. Presently Japanese and Japanese-American children's performance on this perceptual matching task is being examined. Hopefully this data will shed light on the contribution of language and culture to the differential salience of attributes and language strategies for coding matches.

The implications of this study for school performance are important. Teachers often expect children of the same age to respond to cognitive tasks similarly, despite the type of task or language spoken by the child. But, plainly, the availability or unavailability of an appropriate information-packaging rule in the child's language may spell comparative success or failure in the task at hand. The prenominal adjective ordering rule in English provides a way for adult speakers to coordinate four attributes within one utterance to meet the linguistic demands imposed by the communication task. However, what we find when we compare the English-speaking children's relevant feature production with their linguistic coordination performance (see Tables 1 and 2) is essentially a floor effect. On the average, English-speaking children are producing about two relevant features in initial encodings and less than two in final encodings. In both cases their linguistic coordination scores are clearly below the median for all language groups. Specifically, English-speaking kindergarteners and second graders are producing no relevant attributes or only one relevant attribute 50% to 70% of the time for both initial and final encodings. To the extent that two relevant attributes were produced, they were coordinated about half the time.

On the other hand, as Spanish speakers increased their relevant feature production from initial to final encodings and from kindergarten to second grade their linguistic coordination scores also increased. Whereas 67% and 59% of initial encodings contained no relevant features or only one for Mexican kindergarteners and second graders (and 19% and 8% for Chicano subjects), these percentages had decreased to 22% and 7% by the final encoding (and 19% and 7% for Chicano subjects). Moreover, as more relevant features were produced they were coordinated more than 85% of the time for Mexican subjects and more than 50% of the time for Chicano subjects into descriptors such as Es un perrito, un camello amarillo con bolitas or un perro grande cafe con rayas, rather than into such relatively uncoordinated (but informative) descriptions as un camello

y es amarillo, un perrito con rayas y es amarillo, or un perrito cafe y tiene rayas (see Methods for corresponding coordination scores).

The English speakers' significantly lower relevant feature production and linguistic coordination scores were predicted on the basis of prenominal adjective ordering rules in English. We were somewhat surprised, however, to find the relatively poor performance extending throughout the second grade. Previous referential communication studies (cf. Glucksberg, Krauss, and Higgins, 1975) have typically found increasing age to be a reliable predictor of improved performance. In fact, in a previous study with children from a higher socioeconomic class (Foorman, 1975) the senior author found "Knowledge about" and "Knowledge how to use" prenominal adjective ordering rules to be increasingly evident in production and comprehension. In the present study, however, a clear distinction between "Knowledge about" versus "Knowledge how to use" the rules was not demonstrated in production or comprehension due to the floor effect in both domains. One possible reason for this floor effect was that 50% of the children in each grade level of the English-speaking sample had Spanish surnames, even though their teachers and the experimenters found them to be English dominant. Their exposure to a bilingual environment could be inhibiting their acquisition of prenominal adjective ordering rules in English. Such conjecture, however, is not supported by a difference in the English-speaking sample between Spanish surname and non-Spanish surname children's performance in the communication task. In addition, one cannot dismiss the floor effect in the English-speaking sample to some unique environmental factor because the Chicano data came from the same school.

The improvement across grade level exhibited by the Mexican group has implications for a schooling factor which appears to vary across cultures. When attention is focused on the two Spanish-speaking groups, we see that the Chicano children performed significantly better than the Mexican children in the number of adequate initial encodings and, consequently, the number of steps of feedback.

The relative linguistic coordination of attributes was also higher for the Chicano children in the initial encodings. But the interesting observation is that it was the Mexican group that showed the greatest gain in the grade level by language group interaction for final encodings. Moreover, only for the Mexican group was grade level significantly correlated both with the number of attributes given in the final encoding ($r = .64$, $p < .001$) and with the level of linguistic coordination in the final encoding ($r = .55$, $p < .001$). In addition, the trial by language group interaction in the perceptual task (see Figure 1) revealed the Mexican children to be exhibiting a slightly more accelerated rate of learning than the Chicano children.

The obvious questions to ask are Why is the Mexican group showing such improvement across grades? and Why isn't the Chicano group continuing its superior performance with respect to the Mexican group? Both questions may be relevant to explaining performance. The answer to the first question most probably lies with the lack of an organized curriculum in Mexican kindergartens compared to the United States. In fact, kindergartens are relatively rare in Mexico. But by age seven Mexican children are exposed to the kinds of curricular activities that would facilitate performance on perceptual and communication tasks.

The answer to the question concerning a possible decline in the rate of performance across grades by the Chicano children is less obvious. One possibility might be that with increasing age the use of Spanish by Mexican-American children is encouraged less and less, even in bilingual education settings. All of the Chicano children in this study had been born in Houston and were described by their teachers as dominant in Spanish. Yet the seven year olds were clearly more reluctant to use their Spanish in school than were the five year olds. One seven year old boy explained to the Chicano experimenter that he had promised his parents that he would not speak Spanish at school. Under such poor affective conditions for using one's native language it would not be surprising to find

the rate of linguistic development to decline across grades.

In sum, further cross-cultural work is needed to map the differential effects of languages on childrens' ability to perform cognitive tasks. Specifically, future investigations could examine the age at which use of the prenominal adjective ordering rule is achieved in English speakers and reveal the processing demands imposed on communication performance by such comparatively unique linguistic rules of Spanish as, for example, gender.

## Reference Notes

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Table 1

Table of Means for Communication and Perceptual Task Measures

Broken Down by Language Group and Grade Level

| | | Language Groups | | | | | |
|---|---|---|---|---|---|---|---|
| | | English | | Chicano | | Mexican | |
| Dependent Variable | | K | 2 | K | 2 | K | 2 |
| **Communication Task** | | | | | | | |
| # Rel. Attrib. in initial encoding | | 1.97 | 2.16 | 3.12 | 3.24 | 1.48 | 1.73 |
| | T | 2.06 | | 3.18 | | 1.60 | |
| # Rel. Attrib. in final encoding | | 1.91 | 1.96 | 2.89 | 3.24 | 2.44 | 3.36 |
| | T | 1.93 | | 3.07 | | 2.90 | |
| # Steps of feedback | | 1.86 | 1.52 | .82 | .70 | 2.03 | 1.76 |
| | T | 1.69 | | .76 | | 1.90 | |
| **Perceptual Task** | | | | | | | |
| #Rel. Attrib. matched | | 2.10 | 2.23 | 2.50 | 2.85 | 2.79 | 2.99 |
| | T | 2.12 | | 2.68 | | 2.89 | |

Note.- Language Group was significant in:

# of relevant attributes produced in the communication task for (1) initial encodings ($F_{2, 114} = 131.18$, $p < .01$); (2) final encodings ($F_{2, 114} = 32.11$, $p < .01$); and (3) steps of feedback ($F_{2, 114} = 44.87$, $p < .01$).

# of relevant attributes matched in the perceptual task ($F_{2, 114} = 10.83$, $p < .01$).

Grade level was significant in # of relevant attributes produced in final encodings ($F_{1, 114} = 12.65$, $p < .01$) and in an interaction with Language Group for this same analysis ($F_{2, 114} = 4.25$, $p < .017$).

Table 2

Number of Subjects in each Language Group Producing High and Low Levels of Linguistic Coordination in Encodings

| | | Language Groups | | | |
|---|---|---|---|---|---|
| | | English | Chicano | Mexican | |
| Level of Linguistic coordination in initial encodings | 1 | 33 | 2 | 22 | 57 |
| | 2 | 7 | 38 | 18 | 63 |
| | | 40 | 40 | 40 | Totals |

Note.- $\chi^2_2 = 49.52$, $p < .01$

| | | English | Chicano | Mexican | |
|---|---|---|---|---|---|
| Level of Linguistic coordination in final encodings | 1 | 33 | 17 | 8 | 58 |
| | 2 | 7 | 23 | 32 | 62 |
| | | 40 | 40 | 40 | Totals |

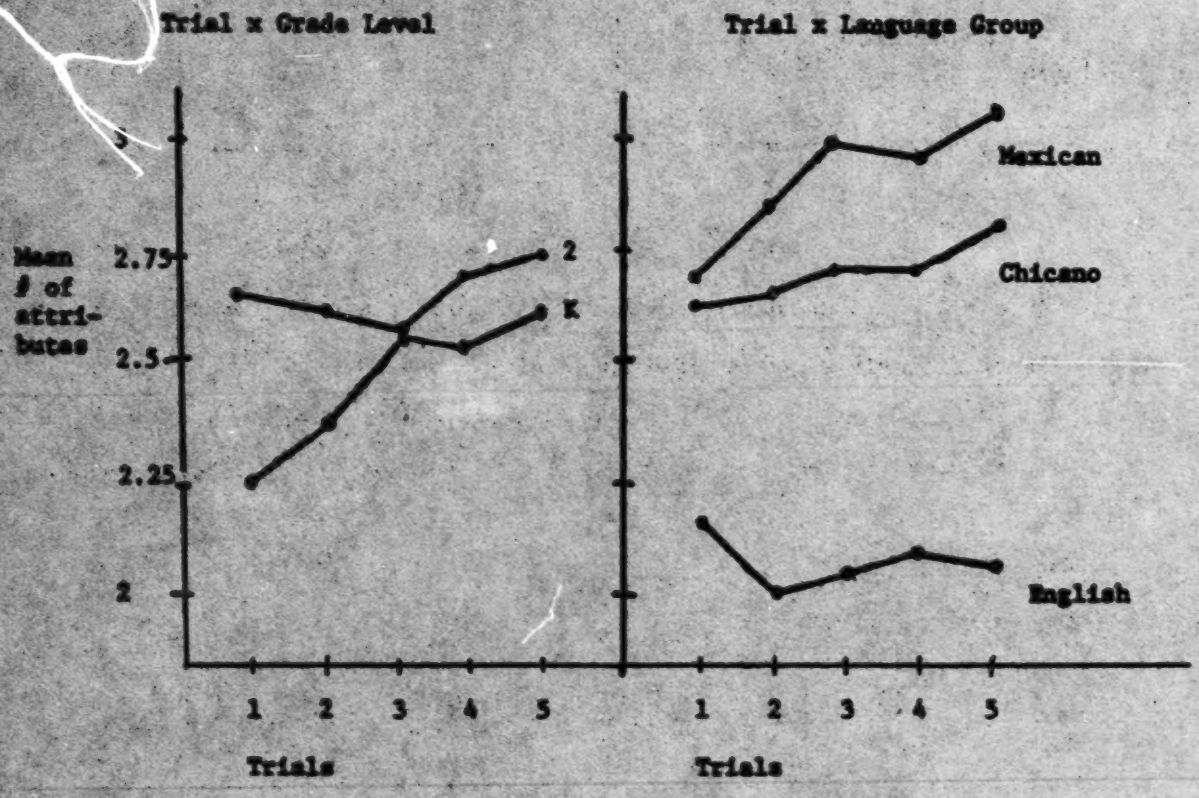
Note.- $\chi^2_2 = 32.10$, $p < .01$

Note.- Linguistic coordination scores across five trials have been dichotomized around the median and represented here as high (#2) or low (#1).

Figure 1

Interactions of Trials x Grade Level

and Trials x Language Group in the Perceptual Task




Note.- Trials x Grade Level is significant at $F_{8, 456} = 3.90$ $p < .01$ and Trials x Language Group is significant at $F_{8, 456} = 3.47$, $p < .001$.